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Office of Nonproliferation and Treaty Compliance
Regulatory Policy Division
Bureau of Industry and Security
U.S. Department of Commerce
Room 2099B, 14th Street and Pennsylvania Avenue
Washington, D.C. 20230

Reference: RIN 0694-AH80, 85 Fed. Reg. 52934 (Aug. 27, 2020), 85 Fed. Reg. 64078 (Oct. 9, 2020)

Subject: Comments of ASML US LLC on Advance Notice Regarding the Identification and Review of Controls for Certain Foundational Technologies

Ladies and Gentlemen:

ASML welcomes the opportunity to comment on the advance notice of proposed rulemaking ("ANPRM") concerning the identification mandated by the Export Control Reform Act of 2018 ("ECRA") of certain emerging and foundational technologies that will thereby become subject to mandatory export license requirements to certain destinations.

I. SUMMARY OF ASML'S COMMENT

By enacting ECRA, the U.S. Congress established a new process beyond the traditional list review approach for export control to identify critical technologies essential to national security in light of major changes in technology development, especially as technologies relate to information and digital capabilities.

a. Statutory Criteria for Qualification of Technology as Foundational

Four elements or criteria are set out in ECRA to determine which technologies will qualify as foundational under the new initiative for emerging and foundational technologies ("ECRA Initiative"). Foundational technologies must be: (i) within the definition of technology that does not include articles, equipment and software, (ii) recently or newly foundational or constituting a new or novel application of a mature foundational technology, (iii) not subject to multilateral controls so as not to be duplicative of existing controls and (iv) essential to U.S. national security. *Technologies relating to semiconductor manufacturing equipment in general, and semiconductor lithography equipment in particular, do not meet the statutory criteria for foundational technology and thus should not be part of the ECRA Initiative.*

- The ECRA Initiative is limited to technology, including semiconductor manufacturing technology. Thus, the criteria would not include semiconductor manufacturing systems, equipment, parts, components and software. These should remain subject to the standard list review process and outside the bounds of the ECRA Initiative.

- Although within the definition of technology, technology for semiconductor manufacturing equipment is not new and has no new potential applications beyond the development, production or use for manufacturing semiconductors.

- Advanced technologies for the principal categories of semiconductor manufacturing equipment are currently and appropriately subject to national security review and, in most cases, control pursuant to the traditional list review and multilateral process and have been for decades.

- Lastly, technology relating to semiconductor manufacturing in general, and semiconductor lithography in particular, does not meet the heightened standard of "essential to the national security" of the United States.

    - Technology for semiconductor manufacturing equipment, while an underlying and at the leading edge an advanced technology, is simply not a strategic differentiator for national security.

    - While some leading edge semiconductor manufacturing equipment technology can be used to produce electronic devices that in turn can be used for military purposes, such technology is not necessary to produce devices for military and intelligence advantage, let alone essential to national security.

Thus, technologies specific to semiconductor manufacturing equipment, including semiconductor lithography technology, should not be subject to export classification or control based on a determination of "foundational technology" pursuant to the ECRA Initiative and this rulemaking.

b. Statutory Guidance and Safeguards Applicable to Imposition of Export Control

Even if semiconductor manufacturing technology in general, or semiconductor lithography technology in particular, is somehow found to qualify under the criteria for the ECRA Initiative, ECRA contains mitigating safeguards that should preclude the application of a statutory export license requirement.

These traditional safeguards, such as foreign availability, benefits to the economy, and protection of technology leadership, should prevent imposing control under the ECRA Initiative on technology for semiconductor manufacturing equipment. These considerations are fully articulated in the comments of SEMI, the global industry association representing the electronics manufacturing and design supply chain, filed in this ANPRM.

c. Semiconductor Lithography Technology Is Not a Chokepoint or Core Strategic Technology

Semiconductor lithography technology is an advanced technology and, together with related technologies like etching and deposition, is a core technology for semiconductor manufacturing. Consequently, it is sometimes characterized as foundational or a chokepoint or core strategic technology. Because of its prevalence, ASML would like to take the opportunity to put this notion in proper context and clarify that semiconductor lithography technology does not enable special advantages or capabilities for military articles or applications. As semiconductor manufacturing has become more globally dispersed and standardized, its strategic significance has diminished while its commercial significance has expanded. Therefore, it is not a chokepoint or core strategic technology.

- The slowing of dimensional scaling and the proliferation of new semiconductor technology in areas such as low power, chip functionality and architecture scaling have meant chip design and system integration have become more important to military or intelligence performance than semiconductor manufacturing capability.

- Even in the area of commercial semiconductor manufacturing, while ASML's latest semiconductor lithography systems and technologies are readily available to all U.S. semiconductor companies, they

are used only to a lesser extent, and in some cases not at all, by U.S. semiconductor companies in their leading edge manufacturing, which is contrary to what non-U.S. competitors to the U.S. semiconductor companies are doing. This illustrates that the U.S. semiconductor industry does not need leading edge lithography technology to maintain its global technology leadership.

d. Answers to Specific Requests from BIS (ANPRM Questions)

In Appendix A, ASML addresses the specific requests of the Bureau of Industry and Security ("BIS") as set forth in the ANPRM.

II. ASML INTRODUCTION

ASML, a world leader in semiconductor lithography technology and systems, is a multinational company headquartered in the Netherlands and with a strong presence in the United States. ASML employs well over 5,500 people in the United States and undertakes research and development, manufacturing, and supply-chain activities in the United States. Further, key ASML customers are headquartered in the United States.

ASML's technology and engineering expertise as well as its global activity is wholly devoted to semiconductor equipment and services, especially lithography, where since its founding ASML has been engaged in accordance with Moore's Law in the development and extension of lithography technology and systems solely for commercial semiconductor manufacturing.

ASML's semiconductor lithography systems are developed, manufactured and assembled in the Netherlands. Although a small percentage of U.S. parts, components and software are utilized in ASML's systems, the technology for the development, production and use of such systems is not of U.S. origin. Indeed, there is no substantial manufacturer of semiconductor lithography systems headquartered in the United States.

ASML's latest semiconductor lithography system based on extreme ultraviolet wavelengths ("EUV") is in its sixth generation and has been in development and refinement for over twenty years. Pursuant to the U.S. and multilateral export control list review process, leading edge semiconductor lithography systems are subject to national security and multilateral control. As they have become trailing edge, semiconductor lithography systems have been routinely decontrolled for national security purposes pursuant to the same process.

ASML complies with all applicable export controls in all jurisdictions in which it does business, including the multilateral controls of the Wassenaar Arrangement.

III. STATUTORY CRITERIA FOR QUALIFICATION OF TECHNOLOGY AS FOUNDATIONAL

ECRA established an initiative to identify "emerging and foundational" technology – two distinct types of uncontrolled technology that are or are likely to become critical technology of the future. As a practical matter, the largest category of such uncontrolled technology is information technology, in contrast to technologies like semiconductor manufacturing technology that have long been subject to national security review and control. By its purpose and terms, ECRA was not intended to replace or duplicate controls on technology already subject to national security review merely by identifying it as "foundational."

The ECRA Initiative should be directed toward a new generation of information technologies. Under ECRA, technology *includes* information, in tangible or intangible form, necessary for the development, production, or use

of an item."[1] The use of the word "includes" is non-exhaustive, encompassing the idea that "technology" extends beyond information necessary for the development, production, or use of an item, the traditional approach utilized in the list review process.

Historically, export controls have been applied through the identification of specific types of articles, equipment, material and software that are to be controlled.[2] Controlled technology has been derived from and tied to controlled articles, equipment, materials and software. In the first version of the EAR, "technical data" was defined to mean "information of any kind that can be used, or adapted for use, in the design, production, manufacture, utilization, or reconstruction of *articles* or *materials*."[3]

As the EAR was subsequently modified and amended, "technical data" and eventually "technology" explicitly referenced "articles" or "materials" or "product[s]." As late as 2016, "technology" was defined as "specific information necessary for the 'development,' 'production,' or 'use' of a *product*."[4] There was no attempt to consider freestanding technologies separate from the products to which they relate.[5]

As part of the traditional list review process, technology has been controlled pursuant to this approach with input from industry Technical Advisory Groups, regular updating and utilization of the multilateral process.

A primary purpose of the ANPRM is to assist in the identification of technologies that would qualify under the ECRA Initiative. ECRA sets forth four elements or criteria, all of which must be present for a technology to qualify as foundational. These elements or criteria should dictate the identification of foundational technologies.

a. First Criterion: Must be Technology, Not Articles or Software

ECRA expands the traditional regulatory focus of technology beyond what is needed to develop, produce or use an item to include stand-alone information technology. On the other hand, it clearly does not expand the definition of technology to encompass commodities and software. The control of these items is appropriately left to the list review process.

Because the existing framework for export controls is based on linking technology directly to tangible products, new emerging and foundational technologies would appear to be a departure from that framework. This new expanded treatment for technology was in part the impetus for the ECRA Initiative. Standard export controls on technology are in some sense backward-looking because controls generally focus on products first and then on the technology needed to develop, produce and use these products rather than considering technologies in the abstract and on their own.

The ECRA Initiative attempts to be forward looking. Emerging and foundational technologies include new information technology not tied to a specific product. These technologies would include artificial

[1] 50 U.S.C. § 4801(11) (emphasis added).
[2] Like the 1969 Act and 1949 Act preceding it, the Export Administration Act of 1979 "envisaged the application of export controls through the identification of specific types of items to be controlled for export purposes. In other words, export controls were to be carried out by identifying problematic items and restricting their export as necessary to promote the goals of the statute." Gregory Bowman, E-mails, Servers, and Software: U.S. Export Controls for the Modern Era, 35 Geo. J. INT'L L. 319 (2004). The 1979 Act was enacted at a time when the landscape was "dominated by physical exports of material products and hardcopy technology such as manuals." As a result, "[t]his world view has strongly influenced the structure of the regulations implemented under this statute." *Id.*
[3] 15 C.F.R. § 379 (1979) (emphasis added).
[4] 15 C.F.R. Part 772 (2016) (emphasis added).
[5] While technology to develop, produce or use technology could be encompassed within the current ECRA and EAR definitions, technologies unrelated to articles, equipment, materials or software have generally not been addressed in the list review process and there is no category in the Commodity Control List for technology relating only to other technology.

intelligence/machine learning, autonomous systems, data cloud flows, applications, quantum computing, cybersecurity algorithms, augmented reality and digital services generally. These technologies in and of themselves can raise national security concerns across a broad spectrum of sectors separate and apart from any connection to the development, production or use of a particular article or software.

Through ECRA, Congress sought to address the U.S. technology advantage vis-à-vis China, especially as it relates to these new emerging and foundational technologies. Indeed, the chief Senate sponsor of the provision which ultimately became the ECRA Initiative specifically mentioned the strategic importance of "companies working in artificial intelligence or in the realm of autonomous vehicles."[6]

This view is consistent with the influential Defense Innovation Unit ("DIU") Report attributing U.S. military superiority in the "third offset" to technologies currently being developed mostly by early-stage technology companies with significant commercial markets.[7] These technologies consist largely of information and communication technologies being developed commercially rather than in the defense sector.[8]

ECRA expands the regulatory focus of technology beyond what is needed to develop, produce or use an item to include stand-alone information technology, but it clearly does not expand the definition of technology to encompass articles and software.

The first criterion of the ECRA Initiative is limited to technology, including semiconductor manufacturing technology. The criteria would not include semiconductor manufacturing systems, equipment, parts, components and software. These should remain subject to the standard list review process and outside the bounds of the ECRA Initiative.

b. Second Criterion: Technology Must be New or Have Novel Applications

To qualify as foundational, a technology must support or have the potential to support critical national security objectives that may go beyond the development, production or use of a particular article or software. Further, the technology should (i) be new or recent, similar to emerging technology, or (ii) if it is mature technology, have novel applications that support or are expected to support the development of other new technology, articles and software. For such technologies, the focus should properly be on potential capabilities or applications.

ECRA was enacted to address, among other things, concerns about new technology or mature technology with novel uses. It was not animated by a desire to recontrol mature technology that is widely dispersed. The DIU report notes that "China is investing in the *critical future technologies that will be foundational for future innovations* both for commercial and military applications: artificial intelligence, robotics, autonomous vehicles, augmented and virtual reality, financial technology and gene editing".[9] These new foundational technologies will support future innovations across many sectors and applications.[10] Senator Cornyn, a key senator involved in the passage of ECRA, echoed the DIU Report's message regarding new technology that will be foundational for future innovation in a public appearance at the Council on Foreign Relations in 2017."[11]

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[6] John Cornyn, *Morning Keynote: "Implications of China's Growing Power for the U.S."* (Nov. 14, 2017), https://www.csis.org/analysis/morning-keynote-implications-chinas-growing-power-us.

[7] Michael Brown and Pavneet Singh, *Defense Innovation Unit Experimental (DIUx) ("**DIU Report**"), China's Technology Transfer Strategy: How Chinese Investments in Emerging Technology Enable A Strategic Competitor to Access the Crown Jewels of U.S. Innovation*, 14 (2018), https://admin.govexec.com/media/diux_chinatechnologytransferstudy_jan_2018_(1).pdf.

[8] *Id*.

[9] DIU Report at 3 (emphasis added).

[10] *Id.*

[11] John Cornyn, *Foreign Investments and National Security: A Conversation with Senator John Cornyn* (Jun. 22, 2017), https://www.cfr.org/event/foreign-investments-and-national-security-conversation-senator-john-cornyn.

In line with these considerations, rather than distinguishing between emerging and foundational technology, ECRA provides the same criteria for the identification and classification of both of these types of technology.

In the past, technology advances were often geared towards military improvements, and the U.S. government was aware of them through the military laboratories and other government-financed technology development. Now innovation and development are coming largely from the private sector and it is very difficult to identify relevant technology when it is in the cradle and is not the result of federal investment. The DIU report states that "the rapidity at which dual-use technologies are developed in the commercial sector has significant impact on the nature of warfare; mastering them ahead of competitors will 'ensure that we will be able win the wars of the future.'"[12]

These new emerging and foundational technologies are expected to be component technologies for future innovations in much the same way that semiconductors have been components in all electronics, telecommunications and computing in the past several decades.[13]

To qualify as foundational, a technology must support or have the potential to support critical national security objectives that may go beyond the development, production or use of a particular article or software. Further, the technology should (i) be new or recent, similar to emerging technology, or (ii) if it is mature technology, have novel applications that support or are expected to support other development of new technology, articles and software. For such technologies, the focus should properly be on potential capabilities or applications.

Semiconductor lithography technology is mature technology that has no new potential capability or application beyond the development and manufacturing of semiconductors. It is not technology that will be foundational to new or novel applications of the future.

c. Third Criterion: Technology Must not be Subject to Multilateral Control

ECRA requires in effect that technologies qualifying under the ECRA Initiative must not be subject to multilateral control on the Commerce Control List ("CCL") or described on one of the other lists of technologies the United States controls for export.[14]

In enacting ECRA, there is no indication Congress was seeking to replace the current list review process or to duplicate it. On the contrary, the ECRA Initiative is designed to supplement the current export control process. A key part of the ECRA Initiative is to bring technologies to multilateral review and control. It would not make sense, therefore, for technologies currently subject to multilateral review and control to be included in the ECRA Initiative.

It would also be consistent with the statutory purpose to exclude from the ECRA Initiative those technologies that have been decontrolled pursuant to multilateral national security review. These technologies that have been

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[12] DIU Report at 2 (citing White House, National Security Strategy of the United States of America, 20 (Dec. 2017), https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf).

[13] DIU Report at 7-8.

[14] ECRA requires that the President "establish and, in coordination with the Secretary, the Secretary of Defense, the Secretary of Energy, the Secretary of State, and the heads of other Federal agencies as appropriate, lead, a regular, ongoing interagency process to identify emerging and foundational technologies that (A) are essential to the national security of the United States; and (B) are not critical technologies described in clauses (i) through (v) of section 4565(a)(6)(A) of this title." 50 U.S.C. § 4817(a)(1). Section 4565 identifies as critical technologies, among other things, items included on the CCL and controlled "(I) pursuant to multilateral regimes, including for reasons relating to national security, chemical and biological weapons proliferation, nuclear nonproliferation, or missile technology; or (II) for reasons relating to regional stability or surreptitious listening." 50 U.S.C. § 4565(a)(6)(A).

evaluated and have long ceased raising national security risks and have become widely available are not likely to now become *essential* to national security.

An exception could be made for mature technologies that were subject to national security review through the list review, multilateral process and that were decontrolled, but only to the extent they have a new potential application that has not been previously considered for national security purposes.

For example, laser technology, a basic and mature technology, has long been evaluated with respect to national security in the list review process relative to the high energy capabilities of lasers. In recent years, however, laser technology has been found to have a new, significant application in quantum computing. This emerging and foundational capability in quantum applications – in contrast to its traditional capabilities – could be grounds for identifying certain laser technology as a foundational technology subject to treatment pursuant to the ECRA Initiative for foundational technology. Such technologies can be expected to be few in number and exceptional in character, thus maintaining a narrow, yet potentially productive focus, for the ECRA Initiative.

The main categories of semiconductor manufacturing equipment such as etching, deposition, lithography and packaging are already appropriately controlled through the multilateral process or have been decontrolled after a thorough national security analysis. Advanced lithography technology has been controlled effectively under the EAR over the last five decades.

ASML's latest sixth generation of EUV lithography systems is already and currently subject to national security and multilateral control. Thus, under the ECRA Initiative, it should not be eligible for control as foundational technology. Furthermore, as deep ultraviolet ("DUV") lithography systems have become trailing edge, DUV technology has been decontrolled from national security requirements including multilateral controls and for many years has been extensively shipped globally, including to China. As such, it is no longer susceptible to control and it, likewise, should be outside the bounds of the ECRA Initiative.

d. Fourth Criterion: Technology Must be Essential to National Security

Technology must be "essential to the national security of the United States" to qualify for treatment under the ECRA Initiative.[15] The standard of "essential" to national security is a higher standard than that currently required to subject items to national security controls under the EAR. Under current regulatory practice, items can be subject to export control merely by posing a national security risk or providing a significant military or intelligence advantage.[16]

Because ECRA contemplates control of technology that is being developed overwhelmingly in the civil sector for civil application, the imposition of export controls pursuant to the ECRA Initiative should require a higher standard. Posing a significant risk to national security does not equate to being essential to national security. Similarly, the mere capability to be used for a military end-use or by military end-users should not elevate technology to "essential" to national security.[17] While determining whether technology is essential to national security requires that certain

[15] 50 U.S.C. § 4817(a)(1).

[16] National security risks are characterized in various ways under the EAR, such as, for example, "it is the policy of the United States to restrict the export and reexport of items that would make a significant contribution to the military potential of any other country or combination of countries that would prove detrimental to the national security of the United States." 15 C.F.R. § 742.4. None of these formulations, however, rise to the level of essential to national security.

[17] Surprisingly in its summary of the ANPRM, BIS seems to equate "poses a national security threat" to "essential to the national security of the United States." These are two very different thresholds or standards. An item may pose a threat or risk to national security without being "essential" to national security. Congress was well aware of this standard but chose instead a higher standard for new emerging and foundational

judgments be made, it is important that any technologies that are deemed essential are found to present a critical risk to national security.

Gradual and continual improvements in semiconductor manufacturing technology, including lithography technology, pursuant to Moore's Law should not create critical or substantial strategic risk, nor should such steady and predictable improvements be deemed essential to U.S. national security.[18]

To the extent semiconductor lithography technology may raise national security concerns – which is not tantamount to being essential to the national security of the United States – lithography technology is already appropriately controlled under the EAR. The leading edge, most advanced semiconductor lithography technology is currently subject to national security controls, and the trailing edge is generally systematically decontrolled. As the trailing edge of technology is decontrolled, it becomes widely deployed and no longer susceptible to control.

In no event should semiconductor manufacturing technology, and semiconductor lithography technology in particular, be deemed to be essential to U.S. national security.

e. Recommendation

Accordingly, semiconductor manufacturing technology in general, and semiconductor lithography technology in particular, does not meet all of the above four criteria. As a result, it should not be part of the ECRA Initiative.

IV. CONSIDERATIONS FOR EXPORT CONTROL SHOULD TECHNOLOGY QUALIFY AS FOUNDATIONAL

Even if semiconductor manufacturing technology or semiconductor lithography technology is somehow found to qualify as foundational technology, ECRA contains a variety of guidance and safeguards that would preclude the application of a statutory export license requirement for this technology.

Consistent with the SEMI comments to the ANPRM, once it has been determined that a technology meets the criteria of the foundational technology initiative, ECRA requires that BIS "take into account" the following considerations before subjecting the technology to control under the ECRA Initiative:

- the development of emerging and foundational technologies in foreign countries;
- the effect export controls imposed pursuant to this initiative may have on the United States, including their impact on the economy and the development of such technologies in the United States; and
- the effectiveness of export controls imposed pursuant to this initiative on limiting the proliferation of emerging and foundational technologies to foreign countries.[19]

These statutory provisions call for:

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technologies – essential to the national security of the United States. It is important in implementing a foundational technology initiative that BIS does not conflate these different standards.

[18] While semiconductors may play a role in emerging technologies such as those involving artificial intelligence, the key to these semiconductor developments is chip design and process technology, not semiconductor manufacturing. *See SIA, Semiconductors: A Strategic U.S. Advantage in the Global Artificial Intelligence Technology Race* (Aug. 2018), https://www.semiconductors.org/wp-content/uploads/2018/08/81018_SIA_AI_white_paper_-_FINAL_08092018_with_all_member_edits_with_logo3.pdf.

[19] 50 U.S.C. § 4817(a)(2)(B).

- BIS to identify foundational technology, "only after full consideration of the impact on the economy of the United States" and if controls on that technology would not harm U.S. development of, or threaten U.S. leadership in, that technology;

- Foundational technology controls to be narrowly tailored to further specific and essential U.S. national security interests; and

- Foundational technology to exclude technology available outside the United States;

Analysis of these factors highlights that semiconductor manufacturing technology, including lithography technology, should not be subject to foundational technology controls. This is especially true for core semiconductor lithography technology, which has been developed and is available only outside of the United States.

Unilateral U.S. controls on semiconductor lithography technology create an incentive to isolate the technology away from the United States, undermine the global technology leadership of the United States and its allies in semiconductor manufacturing and impose a very heavy economic cost on the wellbeing and prosperity of consumers worldwide.

V. SEMICONDUCTOR LITHOGRPAHY IS NOT A CHOKEPOINT OR CORE STRATEGIC TECHNOLOGY

While semiconductor lithography technology is advanced technology and is sometimes loosely characterized as foundational or as a chokepoint or core strategic technology, ASML respectfully submits that semiconductor lithography technology and systems do not qualify as critical or of unique significance to the national security of the United States or its allies.

a. Advanced Semiconductor Manufacturing Is Not a Core Differentiator for Advanced Electronics Systems

Semiconductor manufacturing's contribution to advanced electronics has become more generic as it has become more standardized, disaggregated and internationally dispersed.

While many years ago semiconductor manufacturers built much of their manufacturing equipment, they have come increasingly to rely on independent equipment and materials suppliers as semiconductor manufacturing requirement has become more standardized, complex and expensive. Further, semiconductor foundries provide semiconductor manufacturing capability in multiple locations globally. With the proliferation of foundries, the manufacturing of semiconductors is no longer a principal differentiator for advanced semiconductor devices.

In fact, foundries outside of the United States are the entities most interested in, and have been acquiring, ASML's leading-edge, advanced systems. While ASML's latest semiconductor lithography systems and technologies are readily available to all U.S. semiconductor companies, they are not indispensable to the leading edge manufacturing of U.S. semiconductor companies, who are using these systems sparingly or not at all. This underscores that the U.S. semiconductor industry does not need leading-edge lithography technology to maintain its global technology leadership.

Today, semiconductor manufacturing is driven much more by economics rather than differentiated by applications. In this way, the importance of export controls on semiconductor manufacturing capability and equipment has been significantly diminished in recent years.

b. Traditional Semiconductor Manufacturing and Equipment Face New Challenges with the Slowing of Moore's Law and the Core of Semiconductor Performance is its Design

For over 50 years, semiconductor manufacturing, a mature industry, has pursued a roadmap driven by Moore's Law: ever smaller and higher numbers of transistors on a silicon wafer.

This approach to advancing technology development, however, is not expected to produce the same central benefits as prior semiconductor manufacturing for two primary reasons. First, Moore's Law is inevitably slowing as line widths on certain devices narrow.[20] Physical limits are making it harder, and will eventually make it impossible, to shrink silicon-based transistors further.[21] This is in part due to the end of Dennard scaling, which had until 2005 shown that, as transistors get smaller, the electrical field was held constant, thereby yielding higher speed and a reduced power consumption.[22] Below the 90nm node evidence shows that transistors become smaller but this does not mean that they perform better, it merely means that they are less expensive.[23]

Moore's Law has always been driven by dimensional scaling combined with other scaling engines. As dimensional scaling slows, the emphasis of innovation continues to focus on circuit scaling, device scaling and architecture scaling, which are not dependent on advanced lithography systems. These other areas of innovation include "progress on energy consumption, 'system on a chip' functionality"[24] and other dimensions such as microarchitecture, system optimization, advanced packaging and new devices and materials.

While some leading edge semiconductor manufacturing equipment technology can be used to produce electronic devices that can be used for military purposes, such technology is not necessary to produce devices for military and intelligence advantage, let alone essential to national security.

Crucially, the core of semiconductor performance is its design. Device design and system integration technologies generate far more value for intelligence and military articles. Most advanced devices manufactured with leading edge semiconductor lithography systems are for large volume, low cost and high yield applications. These features are crucial for commercial applications but unnecessary for specialized intelligence and military applications.

Further, new technology developments centered on quantum computing, artificial intelligence, 5G, and other areas of information technology – precisely those targeted by the emerging and foundational technology initiative – are more likely to be crucial to electronic systems of the future and hence to national security than scaling and miniaturization. And China's People's Liberation Army also appears to be focused on advances in new emerging areas of information technology. The Chinese army has identified controlling the "information domain" as "a prerequisite for achieving victory in a modern war and as essential for countering outside intervention in a conflict."[25]

The development and refinement of dozens of technologies for semiconductor manufacturing including lithography are aimed at improving and expanding traditional semiconductor manufacturing pursuant to Moore's Law. Such

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[20] Executive Office of the President, President's Council of Advisors on Science and Technology, Report to the President – Ensuring Long-Term U.S. Leadership in Semiconductors, 6 (Jan. 2017), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_ensuring_long-term_us_leadership_in_semiconductors.pdf.
[21] *Id*.
[22] Lennart Johnsson, University of Houston, *The Impact of Moore's law and loss of Dennard Scaling* (Feb. 2015), Advanced Computing Research Laboratory (ACRL), https://indico.cern.ch/event/397113/contributions/1837780/attachments/1215934/1775678/Talk_2016-01-21.pdf.
[23] *Id.*
[24] *Id*.
[25] Defense Intelligence Agency, *China Military Power Modernizing a Force to Fight and Win*, 45 (2019), https://admin.govexec.com/media/gbc/docs/pdfs_edit/dod-2019-china_military_power_final.pdf.

gradual improvements should qualify neither as a new strategic risk or application nor as a new core technology essential to U.S. national security.[26] Major breakthroughs or innovations in DUV took place many years ago. Such innovations and breakthroughs are not expected in the future. Rather, ASML expects only gradual innovations primarily aimed at improving productivity for high volume manufacturing of devices for commercial applications.

VI. CONCLUSION

Based on an analysis of the statutory requirements, semiconductor manufacturing equipment technology in general, and semiconductor lithography technology in particular, should not be captured by attempts to identify foundational technologies under the ECRA Initiative.

Instead, efforts to identify foundational technology should focus on new and developing technologies that will serve as the foundation for the critical information technologies and systems of the future based on the four elements set forth in ERCA. A focus on the four criteria established by the ECRA Initiative will allow U.S. and allied governments to identify and control critical technologies while preserving the vast benefits these technologies can bring to industry and the commercial sector where they are overwhelmingly developed and deployed.

Sincerely,

Craig DeYoung
Vice President, U.S. Government Affairs
ASML US LLC

Enclosure

[26] While semiconductors may play a role in emerging technologies such as those involving artificial intelligence, the key to these semiconductor developments is chip design and process technology, not semiconductor manufacturing. *See* SIA, *Semiconductors: A Strategic U.S. Advantage in the Global Artificial Intelligence Technology Race* (Aug. 2018), https://www.semiconductors.org/wp-content/uploads/2018/08/81018_SIA_AI_white_paper_-_FINAL_08092018_with_all_member_edits_with_logo3.pdf.

Appendix A – Recommendations in Response to Specific Requests from BIS

Certain of the suggestions offered by BIS in the ANPRM do not appear to take into account the distinction between new technologies and mature technologies with novel applications on the one hand and technologies that are directly related to the development, production or use of a controlled item and have established applications on the other.

The ANPRM identifies for evaluation as foundational technology items that are currently subject to control for military end-use or end-user reasons. Such items include various semiconductor manufacturing-related equipment, software and technology controlled for AT reasons under the EAR. The ANPRM further notes there may be additional items classified on the CCL at the AT level or as EAR99 that should be evaluated and specifically mentions (i) items being utilized or required for innovation in developing conventional weapons, enabling foreign intelligence collection activities, or weapons of mass destruction applications and (ii) technologies that have been the subject of illicit procurement attempts that may demonstrate some level of dependency on U.S. technologies.

Including semiconductor manufacturing technology, software and commodities in an exercise aimed at foundational technology is misguided and not consistent with ECRA's statutory terms or purpose.

The utilization of an item in conventional weapons or the fact that technologies have been the subject of illicit procurement attempts are unrelated to whether an item or technology is foundational or meets the requirements of ECRA. As noted, ECRA's mandate on emerging and foundational technology is focused on technology – not software or commodities – that is not subject to multilateral controls and is essential to national security. The normal list review process – not the ECRA Initiative – should be used to evaluate the proper control level for the items BIS identifies in the ANPRM.

The process of identifying foundational technology should not be used as a guise to recontrol commodities, software and technology that have already been evaluated for national security risks pursuant to a multilateral process and that, in some cases, were specifically decontrolled because they were determined not to present a significant national security risk, let alone be essential to U.S. national security. These items are generally already appropriately controlled under the current list-based system. If their control status is deficient, it should be corrected pursuant to the list review process, not pursuant to the ECRA Initiative.

Request 1: Definition of Foundational Technology

To qualify as foundational technology, technology should be required to meet the key statutory criteria:

- Technology, not articles or software, including that beyond what has traditionally been tied to the development, production and use of a specified item;
- Foundational in the sense that it, like emerging technologies, is new or recently new and if mature has new novel applications that support or are expected to support the development of other technology and items;
- Not subject to multinational review or control; and
- Essential to national security.

Technology defined in ECRA is broader than the current definition in the EAR, but not so broad as to encompass commodities or software. To include commodities and software within the definition of technology is to defy and do violence to the common sense meaning of the word, is fundamentally inconsistent with the principles and definitions embedded in ECRA and in the EAR and will inevitably lead to an overlap of "foundational technology" with articles listed on the CCL.

The technology should be newly or recently foundational. It should have subsequent items – whether commodities, software or technology – that are or potentially will be dependent on it with the potential to support items or activities essential to U.S. national security.

Technology eligible for the ECRA Initiative should not be the subject of multinational review or control. Technology that is subject to national security control or that has been subject to national security review through the list review and multilateral process should be excluded.

A limited exception would be appropriate for mature technology previously subject to national security scrutiny in the list review process and subsequently decontrolled that has a new application or capability not previously assessed in the list review process. In this case, the technology should be reviewed to determine whether its connection to the new technology makes it essential for national security. If so, it should be identified as a new foundational technology. But this is surely a very unusual case and one that would likely not apply to technology for semiconductor manufacturing equipment, including semiconductor lithography technology.

The technology must be "essential" to national security. This is a much higher standard than merely posing a national security risk or being able to be used for military end-use or by a military end-user. The items that are or will be dependent on the technology would also need to be meet this higher national security standard.

Request 2: Criteria for Identifying Foundational Technologies

The criteria for identifying foundational technologies for this ECRA initiative should largely overlap with the definition of foundational technology contained in ECRA and outlined above.

Technology identification should focus on information capabilities, data manipulation and mining and know-how that are likely to enable the development or production of items yet to emerge or the development, manipulation or storage of information critical to national security. These are the technologies that have not generally been considered in the list review process.

The technology should exclude commodities or software.

The technology should not be currently or previously subject to control for national security reasons. In particular, technology should not qualify under the foundational technology initiative if it has been subject to national security control through the list review process and decontrolled through the same process. There should be an exception for technology that has a new application or capability and has not previously been assessed in a national security context.

Most importantly, the technology should be "essential" to national security, not merely posing a risk to national security or capable of military end-use or use by a military-end user. Technology controlled for AT reasons or that is EAR99, and that has previously been reviewed for national security and determined to no longer pose a national security risk justifying national security controls, should generally remain outside the bounds of this initiative.

Request 3: Process to Determine Foundational Technology

A new collaboration between industry, large and small, and U.S. government is crucial to the appropriate identification of foundational technologies. Focusing as a first step on AI as a principal area of concern would be in line with the reasons for the ECRA Initiative.

In addition, the focus should be on identifying new technologies that could be foundational in important areas relevant to national security. The focus should be forward looking – examining technologies that have the potential to be foundational to items of the future rather than necessarily waiting for a definitive connection to a controlled item or service.

Pursuant to ECRA, the interagency process to identify foundational technologies must consider whether controls will be effective in limiting foreign access to technology. There is no U.S. manufacturer of semiconductor lithography systems. In these circumstances, unilateral U.S. export controls on semiconductor lithography technology will ultimately not be effective, advantage companies with no U.S. footprint, and create an incentive for those non-U.S. companies that operate in the United States to move operations overseas.

Request 4: Status of the Development of Foundational Technology Overseas

ECRA requires consideration of the development of foundational technologies abroad.[27]

First, lithography systems and technology are not foundational within the meaning of ECRA. Second, lithography systems and the technology on which they are dependent are developed largely outside of the United States. There is no major U.S. manufacturer of semiconductor lithography equipment.

In these circumstances, unilateral controls on lithography technology are unlikely to preclude the technology reaching the target of the control, and they create an incentive for non-U.S. companies to move their operations out of the United States. They also impose a major cost on U.S. and allied economies by impairing the vast commercial benefits that accompany semiconductor manufacturing.

Request 5: Impact of Foundational Technology Controls on Development in the United States

Pursuant to ECRA, the interagency process to identify foundational technologies must consider the effect of any controls on the development of these technologies in the United States.

Unilateral controls impose a heavy competitive burden on U.S. and allied industry. These controls can contribute to customer efforts to avoid or "design out" U.S. origin products and technology. The controls limit the scale of operations of companies operating in the United States, thereby making new technologies uneconomic.

Again, unilateral controls provide an incentive for production and technology development to move outside the United States.

Unilateral controls will invite significant new Chinese investment, only accelerating Chinese efforts to become independent of western semiconductor technology. By closing the Chinese market to Western companies, Chinese

[27] 50 U.S.C. § 4817(a)(2)(B)(i).

technology dependence will decline along with the ability of Western companies to maintain global technological leadership.

Lastly, imposing national security controls provides a major impetus for foreign countries to develop domestic competitors to U.S. industry and industry of allied governments.

Request 6: End-Use or End-User and Technology-Based Controls

BIS recently enhanced end-use and end-user controls on various items, including those related to semiconductor manufacturing. These end-use and end-user controls bear no relationship to whether these technologies are foundational or "essential" to national security. But to the extent BIS is concerned about national security implications of these items, end-use and end-user controls and the license requirements they impose should be more than adequate to address these concerns.

Indeed, end-use and end-user controls can be very effective through the imposition of licensing conditions or requirements. Because most new foundational technologies can be expected to have their applications almost entirely in the commercial sector, imposing broad, general licensing requirements or denying license applications without concern to end-use or end-user places a costly restriction on the revenue from and use of these technologies in the commercial sector.

Carefully formulated and effectively maintained end-use or end-user constraints or conditions can provide national security protection without the enormous economic costs of broad export denial policies.

For semiconductor manufacturing technology and equipment, there may be a variety of collateral constraints or conditions that can provide substantial national security protection against illicit end-use or end-users while still enabling major commercial benefits of exporting. New technology capabilities can greatly enhance the effectiveness of collateral constraints. The U.S. government has a history of successfully incorporating effective collateral constraints on semiconductor manufacturing in foreign countries and this should provide a basis for working with industry to develop future collateral constraints that allow exports to proceed with minimal national security risk.

BIS licensing policy on foundational technologies should take end-use/user controls and individual collateral constraints into account and should not veer towards a policy of broad conditions on or blanket denial of exports to arms embargoed countries.

Request 7: Other Approaches to the Issue of Identifying Foundational Technologies Including the Stage of Development or Maturity Level Warranting Control

Rather than using the foundational technologies identification process to recontrol technology, software and items that have already been subject to national security review, the better approach is for BIS to focus on new technologies not set forth on the CCL with the potential to significantly enhance the performance of commercial as well as military systems and that meet the criteria outlined above.

Items subject to anti-terrorism controls, like items subject to national security controls, are generally appropriately controlled under the current list-based system. If items currently on the CCL and controlled for anti-terrorism reasons are to be captured, it should be because of their connection to emerging sectors like artificial intelligence and quantum computing.